Prioritized Technology: System Autonomy – Efficient Planetary Surface Science Ops

Technical Goal

Significantly increase the efficiency of planetary surface science operations

- Increase science productivity of surface missions by increasing work efficiency index by at least 300%
- Increase efficiency of collecting, triaging, and returning informative data

Major challenges:

- Reducing overhead time requires in-situ probe (e.g., planetary rover) to operate reliably and robustly while independent of ground control
- In-situ probe needs high-level awareness beyond primitive actions and adapt when operating incorrectly or sub-optimally
- In-situ probe should be capable of monitoring its actions, diagnosing problems, and optimizing, reconfiguring, and repairing autonomously

Technology advances are required in:

- Situational/self awareness: sensing and perception, state estimation, knowledge and model building, anomaly/event detection
- Reasoning/acting: goal-based planning, task execution, diagnostics and prognostics (system health management)

Technical Status

- Routine MER/MSL science ops requires multiple sols to approach a target, perform terminal alignment, and instrument deployment.
- 2004 "Single Cycle Instrument Project" (SCIP) demonstrated capability to perform instrument deployment in a single command cycle, which is a work efficiency gain of at least 300% (TRL 5)
- 2003-2015 "Life in the Atacama" (SMD ASTEP) demonstrated autonomous long-range traverse, science autonomy, and sampling (TRL 5)
- 2014 "Mojave Volatiles Prospector" (SMD MMAMA) demonstrated fully autonomous rover navigation in support of high-tempo science operations (TRL 5)
- 2014 "Planetary Lake Lander" (SMD ASTEP) demonstrated high-efficiency science operations using on-board situational/self awareness and reasoning/acting (TRL 5)

Mission Applications

- Planetary science operations constantly deals with down-sampling, data prioritization, and trades. Optimizing mission performance and science productivity is a critical priority and calls for delegating some of the decision-making to the in-situ probe.
- Increasing operational efficiency will directly increase the number of sites that can be visited in a given period and science productivity
- Enable surface missions that require rapid measurement, contingency handling, or that are too slow to perform with ground control in the loop will be enabled.
- In-situ probes can establish an environmental, operational, or situational baseline, track changes as they happen, adapt their data collection rate to monitor them, and prioritize data return. This will significantly increase the return of informative science data.
- Increase utilization of in-situ probe (minimize idle time) and communications link (ensure downlink capacity is fully used).

Development Cost and Schedule